The DM-Ice Dark Matter Experiment

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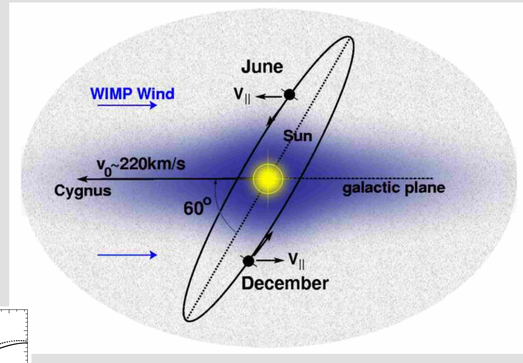
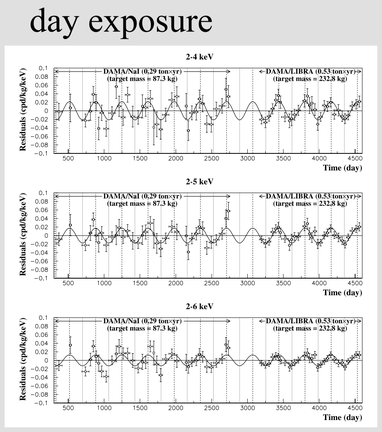
on behalf of the DM-Ice Collaboration

Abstract:
DM-Ice is a new direct detection dark matter experiment planned for deployment deep in the South Pole ice underneath the IceCube Neutrino Telescope. This detector will consist of approximately 250-kg of NaI(Tl) scintillating crystals and will have sensitivity to testing the expected annual modulation in the dark matter signal. Following the results of DAMA/LIBRA and preliminary findings of CoGeNT with respect to this modulation, an experiment in the southern hemisphere will be able to test the hypothesis while eliminating or reversing seasonal environmental and cosmic ray effects.
In December 2010, two prototype units of 17-kg combined crystal mass were deployed at a depth of ~2200 m.w.e.; these units are now taking data. We will report on the current status of the prototype and discuss the full-scale experiment.

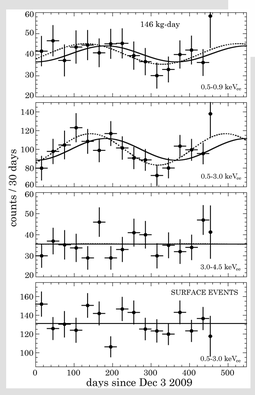
Annual Modulation:

- Modulation of ~7% of dark matter signal expected from most halo models
- DAMA/NaI and DAMA/LIBRA observe modulation over 13 years
- CoGeNT observes a modulation over 442 day exposure





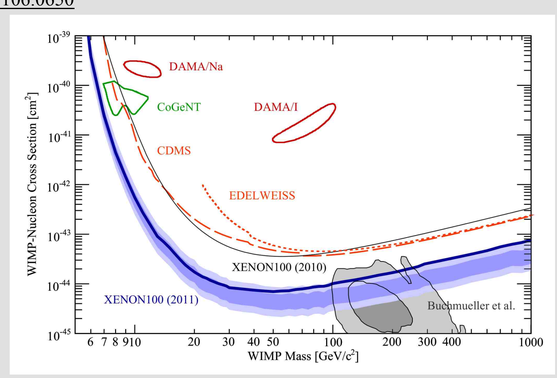
R. Bernabei *et al*. Eur. Phys. J. C (2008)



C. Aalseth *et al*. arXiv:1106.0650

- consistent modulation phase
- some tension for best-fit parameters between experiments
- no modulation in other energy ranges

Tension between modulation claims and best limits from other experiments (XENON100 and CDMS)

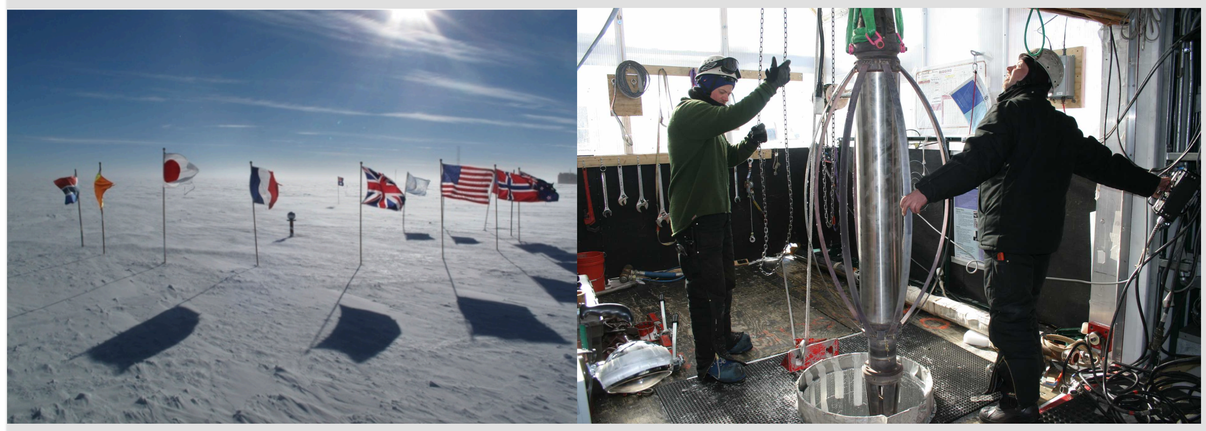


E. Aprile *et al*. arXiv:1104.2549

Motivation for DM-Ice:

Must run NaI(Tl) to test DAMA observation
- Must run with same detector for definitive test
  - Theoretical dark matter models have tunable interactions with nuclei

Must run in the Southern Hemisphere
- Any seasonal effects will have opposite effect



Advantages of the South Pole:

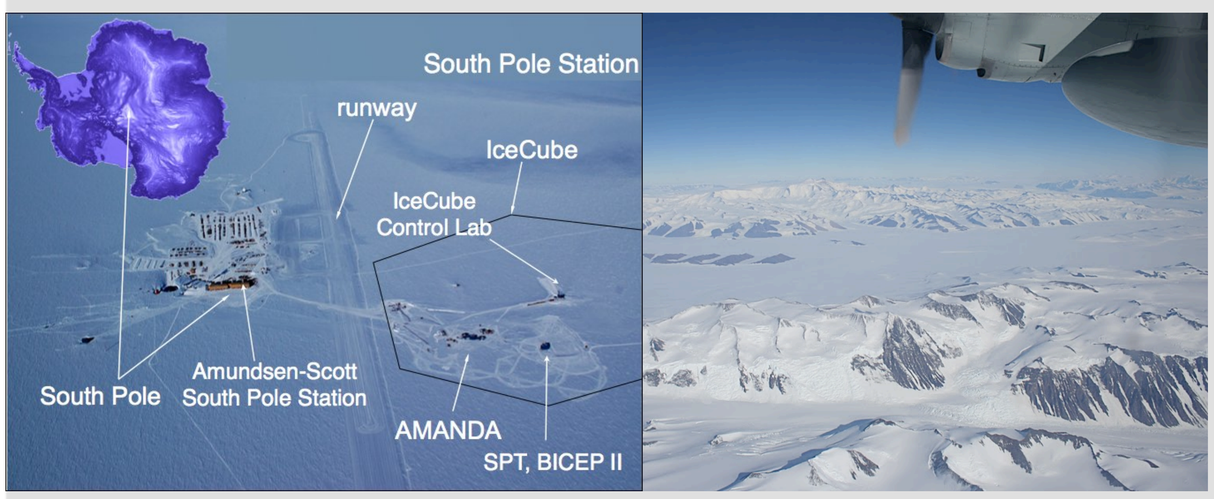
Infrastructure for experiment through Amundsen-Scott South Pole Station
- No underground laboratories available in the Southern hemisphere

Drilling to 2500m established by deployment of IceCube

Muon rate observed to be out of phase with expected dark matter modulation
- IceCube/DeepCore available for muon veto
- Ice surrounding detector moderates neutrons

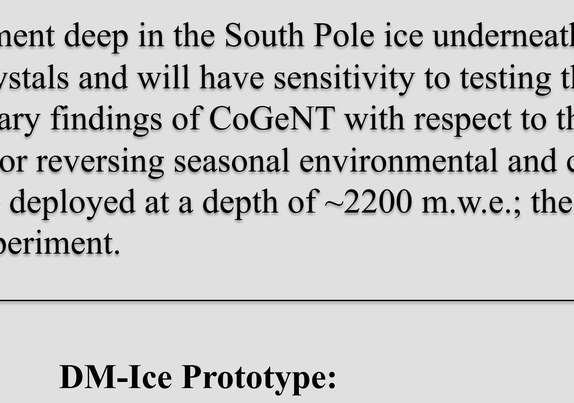
No temperature fluctuation at depth in ice

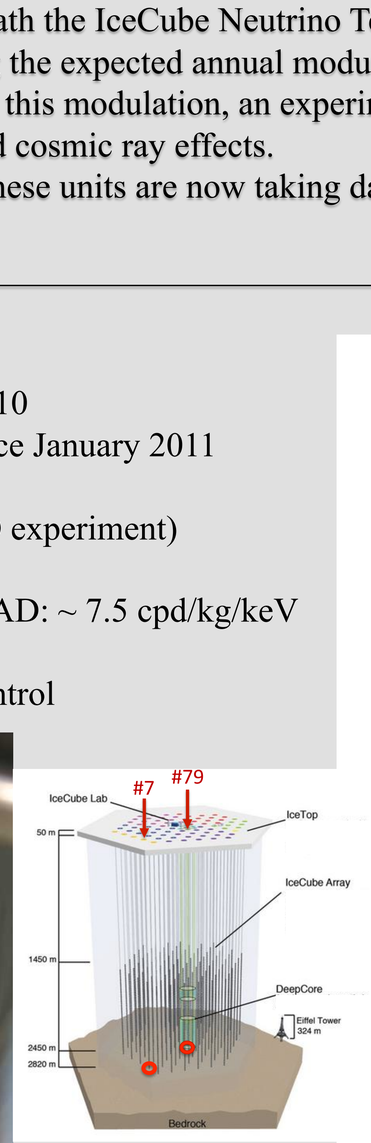
Radiopurity of ice measured to be better than rock
- No radon, ppt of U/Th, ppb ^{40}K

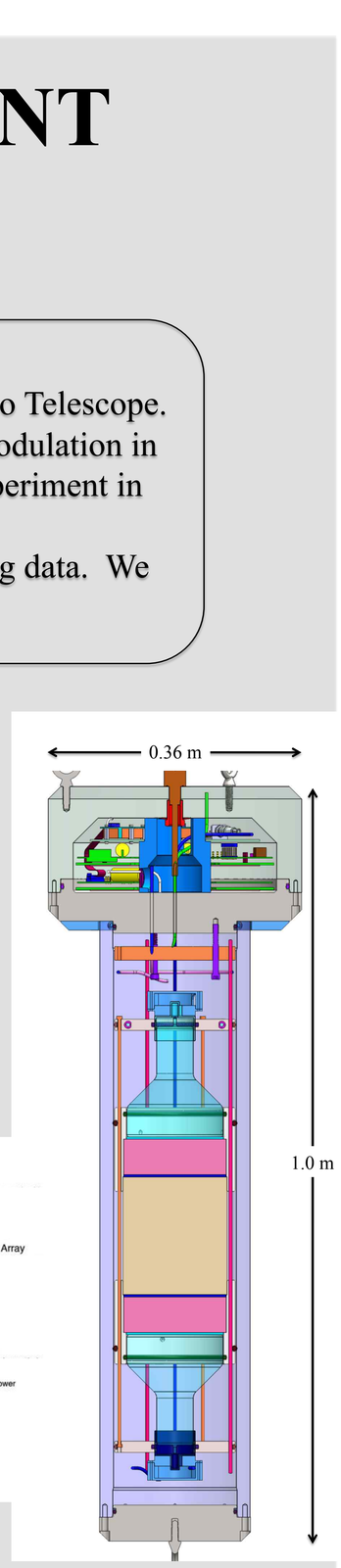


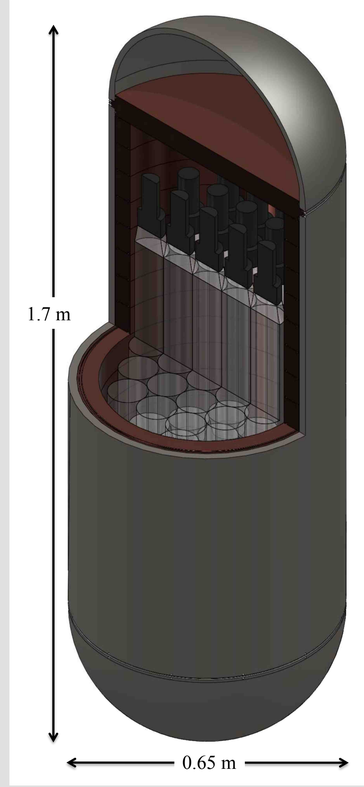
DM-Ice Prototype:

- Two units deployed December 2010
  - Collecting data continuously since January 2011
- Each unit contains:
  - 8.5 kg NaI crystal (from NAIAD experiment)
    - Grown by Bicron
    - Background measured by NAIAD: ~ 7.5 cpd/kg/keV
  - 5” ETL 9390KB53 PMTs (x2)
  - IceCube mainboards and HV control









DM-Ice Full-Scale Detector:

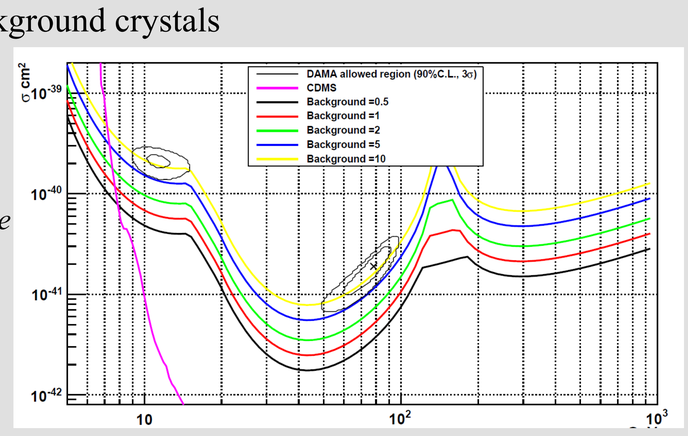
- Projected deployment ~December 2013
- Each unit contains:
  - 6 kg NaI crystal (x19)
    - 95.6 mm diameter, 250 mm length
    - Arrayed for anticoincidence
  - 3” Hamamatsu R11065 PMTs (x2 per crystal)

- 60 mm OFHC copper shielding
- Stainless Steel pressure vessel
  - 650 mm outer diameter
  - 1.7 m length
  - Capable of withstanding 6000 psi freeze-in

Science Capability of DM-Ice:

- Complete coverage of DAMA-preferred regions within 2 years of running
  - Possible even with higher background crystals

*500 kg*yr exposure*
2-6 keV modulation range



See also:

J. Cherwinka *et al.* A Search for the Dark Matter Annual Modulation in South Pole Ice
arXiv:1106.1156

Posters by Bethany Reilly and Antonia Hubbard at this session

DM-Ice Collaboration:

University of Wisconsin, Madison, USA
University of Sheffield, England
University of Alberta, Canada
Pennsylvania State University, USA
Fermilab, USA
University of Stockholm, Sweden

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